NAIC-ID(RS)T-0095-96

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NAIC- ID(RS)T-0095-96

HUMAN TRANSLATION

NAIC-ID(RS)T-0095-96 17 May 1996

MICROFICHE NR: 96C000383

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English pages: 16

Source: Cama, China Astronautics and Missilery Abstracts, Vol. 2, Nr. 4, 1995; pp. 1-10

Country of origin: China
Translated by: SCITRAN
F33657-84-D-0165
Requester: NAIC/TASC/Richard A. Peden, Jr.
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ABSTRACT This article is a part of research on terminal homing associated with space direct collision interceptors. The object is to establish a correct way of thinking about overall designs associated with space interceptor terminal homing, lowering development difficulties associated with various subsystems. After analyzing the basic contradictions associated with terminal homing system design and problems existing in past designs, this article puts forward new thinking associated with the solving of problems--that is, the idea of closely correcting deviations around larger lateral overloads and, in conjunction with that, realizing high precision homing and control, systematically designing terminal homing methods. In conjunction with this, from the angle of overall optimization, the reasonableness of opting for the use of larger lateral acceleration control corrections is verified. From this, the importance of new design ideas in research is clearly shown.

KEY WORDS +Space interceptor Terminal homing design +Lateral acceleation option

I. INTRODUCTION

With regard to a complicated engineering project, people often lay comparative stress on the advanced nature of performance indicators associated with subsystems or components but overlook design optimization associated with the system as a whole, leading to the frequent appearance of the introduction of large numbers of personnel and amounts of materiel to carry out the tackling of key problems associated with components. They are, however, phenomena which cannot be solved for long. An outstanding system designer ought to be able to opt for the use of components which are certainly not very advanced, but--through system optimization--design systems with superior performance.

As far as doing one's best at complicated systems design is concerned--besides considering subsystem performance indicator distributions to plan as a whole--what is even more important is the presentation of new ways of thinking. The angles of new thoughts and new concepts will often make research work show the appearance of aspects which start something new. For example, it is possible--through a certain tiny specialized improvement--to solve a different specialized problem for which there has been no solution method for a long time. It is possible to say that one of the cores of systems work is nothing other than--based on the concrete situation--putting foward new directions of exploration, setting up new lever fulcrums for research work, getting the most progress for the lowest price. Of course, the presentation of a good design concept depends on the beliefs of researchers about problems as well as their depth and breadth of knowledge.

Although direct collision space interceptors are a complicated system which involves many specialized technologies, with regard to its design objectives, however--besides the realization of automatic acquisition and identification--they are nothing other than conversion to light, small models and practical use (that is, guaranteeing as much miniaturization as possible under conditions of direct collision). The direct collision objectives which space interceptors pursue are nothing else than making interception devices capable of shedding their dependence on combat sections, realizing conversion to light, small models, and, only when miniaturization has been realized, is it then possible to make the development of the whole weapons system enter into a positive cycle--increasing survival and combat capabilities to a large extent. Conversion to practical use is nothing other than application to weapons systems as early as possible. One important area associated with the realization of conversion to practical use is nothing else than lessening as much as possible difficulties associated with the development of space interceptors. As far as this requirement is concerned, there is a need--starting from designs--to divide up responsibilities for development difficulties in a reasonable way. To this end, one should put time and energy as much as possible into such soft scientific work as design concepts, new methods of guidance and control, and so on, in order

to facilitate keeping clear of attacking key hardware problems.

II. OVERALL SPACE INTERCEPTOR TERMINAL HOMING DESIGN

1. Special Conditions Associated with Direct Space Collisions

Concrete problems should be dealt with in concrete terms. The targets in space rendezvous are generally orbital spacecraft. This type of spacecraft intercept presents a good number of special characteristics.

(1) Space interceptors generally opt for the use of infrared or visible light detection devices. This is because they operate outside the atmosphere. Not only do atmospheric influences on optical detection devices not exist. It is also possible to more easily make high precision detection, lighten weight, and remain under cover. However, it is also precisely because--as far as opting for the use of passive detection is concerned--detection systems are only capable of acquiring target angle information. It is, however, very difficult to acquire range information.

(2) Due to the fact of opting for the use of optical detection, it is possible to realize imagery detection. Although, for most of the period associated with terminal homing, it is point source detection in all cases, at the end of terminal homing, however, one will still be presented with planar source detection.

(3) Due to the fact that targets are orbital spacecraft, orbital parameters can be predicted. The errors will only depend on the prediction errors associated with orbital prediction systems. If interception devices opt for the use of inertial guidance to act as intermediate homing, errors in hand over points will only depend on inertial guidance system measurement errors. As a result, at the time of hand over, the necessary corrected deviations and the lateral accelerations which need to be provided are not large (compared to the relative velocities of targets and interception devices). Basically, rendezvous orbits assume parallel approach methods.

(4) Space interceptors must opt for the use of direct lateral accleration control. Consideration is given to orbital control engines supplying orbital control forces--in structural terms and in terms of control methods--to be as simple and as light weight as possible. Very seldom is option made for the use of variable thrust engines. However, option is made for the use of constant thrust engines possessing pulse operation capabilities. Moreover, option being made for the use of constant pulse engines, in reality, means that it is necessary to depend on the accumulation of pulse time periods in order to achieve requirements with regard to different overall pulses, thus realizing control force adjustments within a certain range. If there is a need to think of making adjustments in a large range, it is then necessary to /3 develop engines and control methods which adjust over a wide range.

Otherwise, there is then no way to completely satisfy the

requirements presented by spacecraft with regard to engines.

2. Basic Contradictions in Overall Space Interceptor Terminal Homing Designs

In space interceptor terminal homing designs, the problem that is met with first of all is the determination of overall parameters. The primary parameters which are involved are control force magnitudes and control precision, overall detection device parameters, inertial guidance system performance parameters, as well as overall interceptor mass, and so on. When designing various terminal homing subsystem performance parameters, there are three basic contradictions which exist. Moreover, these three contradictions are mutually related and must be considered in planning as a whole.

(1) Contradictions Associated with Space Interceptor Lateral Acceleration Options and Other Subsystem Indicator Options. If corrected lateral acceleration options are relatively small, medium and terminal homing hand over errors, which are corrected in the same way, then need to initiate controls ahead of time. During relatively long periods of time, there is a gradual eliminating of this deviation. However, initiating controls ahead of time, by contrast, necessarily requires interception devices discovering targets at relatively long ranges, identifying targets, and tracking targets. There is a requirement that detection systems possess relatively high performance--perhaps, through increasing inertial guidance measurement precision, making errors associated with terminal homing hand overs as small as possible. If option is made for the use of relatively large lateral acceleration corrections--although drops are necessary with respect to detection systems or inertial guidance systems--there is a requirement, however, for orbital control engines to be able to adjust--within a large range and with high precision--pulse requirements within unit time periods, that is, high speed response and narrow pulse requirements. This type of need is capable of creating increases in orbital control engine system mass and development difficulties.

(2) Contradictions Associated with Constant Thrust Orbital Control Engines and Wide Range High Precision Pulse Adjustments. In order to lighten the mass of orbital control engine systems and simplify control produced by correction forces, normally, option is not made for the use of variable thrust engines which have complicated structures and relatively large masses. Option is, however, made for the use of constant thrust orbital control engines which possess the capability for pulse operational configurations. Moreover, there is a certain constraining relationship between the constant thrust of this type of engine and pulse amplitudes and periods. The longer the range of adjustment is, the more complicated adjustments then are, and the more difficult it then becomes to realize high precision orbital control forces. Besides this, the narrower pulses are, the less full combustion then is. Engine specific impulses drop, thus making it possible to create orbital control systems and increases in the

mass of the amount of fuel required.

(3) Contradications Associated with Orbital Control Systems and Guidance Patterns. Due to the fact that optical system detection does not have range information, in all cases, there is a general option for the use of proportional guidance. If one then speaks in terms of the guidance rules required, the best are guidance rules for what time period requires how large a lateral acceleration. Orbital control systems are then capable of immediately putting out that big a correction force. However, constant thrust engines with simple structures still have great difficulty in satisfying this requirement.

To summarize what has been described above, the focal points of contradiction are concentrated in orbital control system parameter design. If one then speaks in terms of orbital control system design, one should primarily resolve contradictions associated with demands and feasibility. Of course, this also includes whether or not it is possible to take foci of contradictions and the paths associated with solving problems and shift them to other areas--for instance, opting for the use of new guidance rules in order to reduce pressures on orbital control engine designs.

3. Space Interceptor Terminal Homing Design Principles

Due to the existence of the basic contradictions described above, space interceptor terminal homing designs must--on the basis of concrete situations which space interceptor terminal guidance meets with--be considered comprehensively to put forward effective solution methods.

(1) Applications Stressing New Ways of Thinking. Development of a complicated system will frequently have progress in the development of the entire system be influenced due to difficulties in realization associated with various individual subsystems or indices. Solution methods are limited to only two types. One type is to again introduce personnel strength, financial resources, materiel, and time to achieve high indices. The other is to open up new paths to rationally avoid points of difficulty. Speaking in a certain sense, the latter is more important and possesses practical effectiveness.

(2) Stressing Top Level Design and Systems Design. During actual research, people often easily fall into areas of error associated with the thinking of the specialty in question or habits of methodology--for example, the inability to go through changes in other systems in the study of guidance heads in order to lower the degree of development difficulty associated with guidance heads--that is, studying relatively lower level (n+1 or n+2) problems on comparatively higher levels (n level).

(3) Stressing Rational Division of Responsibilities. The purpose of systems design is to plan as a whole in considerations, selecting optimum compromise designs--that is, rationally dividing responsibility for difficulties. In this is included rational division of responsibilities for difficulties between various subsystems. It also includes--during the terminal homing time

phase--rational division of responsibilities for difficulties in software and hardware in order to facilitate making the whole system realize "uniform strength" design. /4

4. Ways of Thinking Associated with Problem Solving

It is very clear that opting for the use of large lateral overload corrections will bring with it enormous advantages for space interceptor terminal homing system design. However, it can also give rise to increases in interceptor mass as well as drops in control guidance precision. This piece of research is very closely wrapped up with opting for the use of large overload corrections. In conjunction with this, as far as this new way of thinking associated with the realization of conversion to light, small models and high precision guidance control is concerned, systematic inquiries are made into problems which can be given rise to by opting for the use of large lateral overcorrections as well as methods for resolving problems.

(1) The standards for judging the goodness or badness of interceptor terminal homing designs are low degree of difficulty, light weight, and high precision--that is, under conditions guaranteeing direct collision, the degree of system development difficulty is minimal and mass is maximally light.

(2) In order to make the degree of development difficulty associated with various subsystems low and overall performance high, option is made for the use of designs associated with large lateral overload corrections. What values to select as correction forces and system development difficulty being minimal is proven in order to facilitate the verification of the reasonableness of selections.

(3) Under conditions satisfying development difficulty being low and overall mass being minimal, inquiries are made into how to assure the precision of homing guidance systems. Continuously regulated lateral overloads with ranges as large as possible are put forward.

(4) Among methods for realizing wide range continuous regulation of lateral overloads, there are regulating the magnitude of forces or regulating the time periods that forces are applied. Due to the fact that regulating forces can possibly increase the complexity of power systems and lead to increases in mass as well as increases in the degree of difficulty associated with development, as a result, it is best to opt for the use of regulating time periods when forces are applied.

(5) Regulation of time periods that forces are applied can be realized through two types of methods. The first is to reduce engine pulse widths and improve quick response, realizing wide range regulation by pulse accumulation differences. The second is controling switching instants and time intervals in order to realize wide range regulation. With regard to the former, it is necessary to develop power systems associated with rapid reactions and narrow pulses (according to reports outside China, 10-5 - 10-6s have already been done). This (in particular, opting for the use of power systems when average thrusts are relatively large) is

capable of leading to development difficulties and increases in mass. With respect to the latter--in regard to pulse width and reaction speed requirements--they will be lower than the former. In conjunction with this, it is possible to increase specific pulses and simplify control. (6)
If option is made for the use of adjusted switch time period intervals and instant methods, and, in conjunction with that, high precision guidance and control is realized, it is then necessary to know range information in order to facilitate accurately predicting encounter points and off target quantities to realize high precision corrections. (7) In order to make realizing the concepts described above easy, take terminal homing periods and divide them into two phases, that is, the terminal homing prephase, which accounts for most of the time. In this time phase, it is possible to relax requirements with regard to homing precision (because the residual errors associated with a previous instant can be corrected at a later instant). The main point to consider is maximum conservation of energy. At the end of terminal homing, the primary contradiction is the elimination of target miss amounts associated with encounter point locations. Due to the fact that this time phase is short, it is possible to make use of simple methods to acquire range information. As a result, option is made for the use of the fastest correction methods in order to satisfy requirements associated with light weight, high speed maneuver, as well as precise and simplified control.

For a schematic of space interceptor terminal homing design concepts, it is possible to refer to Fig.1.

III. SELECTION OF DIRECT LATERAL CONTROL FORCES

1. Presentation of Lateral Control Force Selection Problems

In the previous section, full illucidation has already been made--with regard to overall design concepts--of the necessity of lateral control force optimization. Here, we will summarize as follows.

(1) Opting for the use of large lateral overload corrections, it is possible to shorten the initial time period associated with terminal homing as much as possible or relax medium and terminal homing hand over errors. Thus, it is possible to lower the requirements with regard to detection systems and inertial navigation systems to a large extent.

(2) Opting for the use of large lateral overload corrections (in particular, the realization of adjustability over large ranges), it is possible to satisfy the requirements on lateral control forces associated with guidance rules even better.

(3) Opting for the use of large lateral overload corrections, there is an advantage in handling target maneuvering--in particular, the sudden appearance of maneuvers before approaching target collisions. /5

(4) Opting for the use of large lateral overload corrections will be bound to create increases in the mass of lateral power

systems as well as increases in unit time fuel comsumption amounts.

This increase may or may not give rise to increases in the total mass of space interceptors.

(5) Opting for the use of large lateral overload corrections may or may not give rise to drops in guidance control precision.

Due to the existence of contradictions between the first three requirements with regard to large lateral forces and the last two problems which may possibly appear, lateral forces then become a subject which can be optimized.

2. Lateral Force Optimization Conditions

A subject of study may or may not be able to be optimized. This is primarily determined by whether or not the three areas of characteristics below are present or not--that is, whether or not

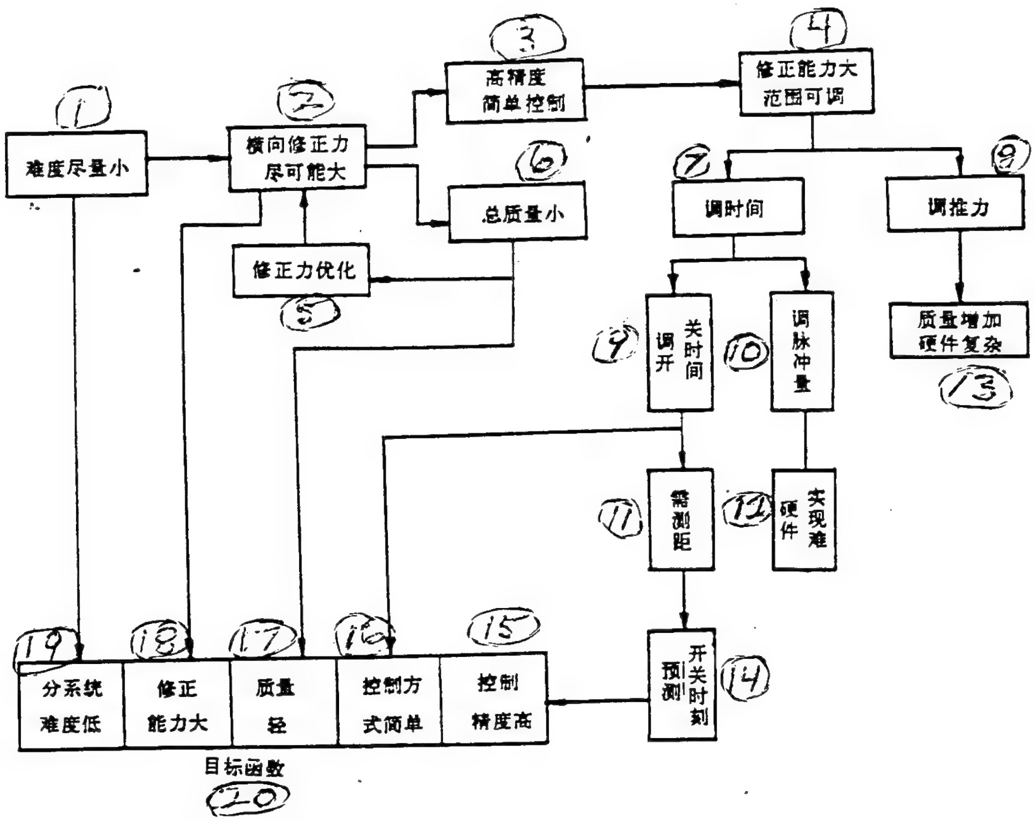

Fig.1 Space Interceptor Terminal Homing Design Concept Schematic

Key: (1) Degree of Difficulty Minimized (2) Lateral Correction Forces Made as Large as Possible (3) High Precision Simple Control (4) Correction Capabilities Adjustable within a Large Range (5) Correction Force Optimization (6) Small Total Mass (7) Time Adjustment (8) Thrust Adjustment (9) Switch Time Adjustment (10) Pulse Adjustment (11) Need Range Finding (12) Hardware Realization Difficult (13) Mass Increased. Hardware Complicated. (14) Switch Time Prediction (15) Control Precision High (16) Control Methods Simple (17) Mass Light (18) Correction Capability Great (19) Level of Subsystem Difficulties Low (20) Target Function

a target function evaluation value exists for it or not, whether or not it is possible to quantitatively describe this target function, and whether or not solutions exist. Speaking in terms of a space interceptor, it just happens to possesses these three area characteristics.

(1) Besides assuring collision accuracy, standards for judging the goodness or badness of space interceptor /6
characeteristics are nothing else than the conversion to light and small models. As far as the collision accuracies in this are concerned, it is possible to make use of different methods of realization, and, in conjunction with this, there is no direct relationship with interceptor mass. However, interceptor mass is an important problem to be considered in designs--in particular, when interceptors also possess a certain level (for example, ten or so kilograms), this is even more the case. The reason is that, as far as space interceptors which are acting as useful load are concerned, each additional 1kg then requires the addition of from 10 or so even up to over 100kg of take off mass in order to accelerate. The reduction of mass very obviously possesses important significance.

(2) Performance indicators associated with various space interceptor subsystems (detection system, inertial guidance system, power systems, and so on) are related to mass in all cases. Moreover, the trend of their influences on overall mass are different from each other. As far as carrying out optimization on system designs is concerned, it is possible to make interceptor mass maximally light.

(3) Although optimization of space interceptor performance is best with multiple targets, due to the fact, however, that it is very difficult to set up comparable relationships between targets, and, in conjunction with that, it makes problems complicated, as a result, it is best if it is possible to discover a single target function which possesses representative characteristics. Overall space interceptor masses possess great influence. In conjunction with this, they are related to various system parameters in all cases. It is a relatively ideal target function.

3. Description of Space Interceptor Overall Mass Optimization

(1) Mathematical Expressions Associated with Optimized Design Problems

If a certain design has n design variables and m constraining conditions, as well as one index for evaluating the goodness or badness of the design, when solving for an evaluation index minimum, the mathematical expression for the optimization design problem is

$$\begin{aligned} &\min_{X \in R} f(X) \\ &R = \{X|_{g_i(x) \geq 0} \quad i = 1, 2, \cdots, m\} \\ &X = (x_1, x_2, \cdots, x_n)^{\tau} \quad x \in E_n \end{aligned} \tag{1}$$

In the equations, f(X) is the target function. R is the feasible

domain of the variable X. X is an n dimensional variable. If f(X) is the linear function associated with design variable X, and constraining condition gi(X) is also a linear function, then, the optimization problem is a "linear programing" problem. Otherwise, it is a "nonlinear programing" problem.

(2) Space Interceptor Mass Target Functions

The overall mass of space interceptors is composed of orbital control power system mass Mp, search system mass Ms, inertial guidance system mass MI, power system fuel as well as storage tank mass MF, and other masses MO which are unrelated to orbital control forces. At this time, the space interceptor mass expression is

$$f(M) = M_P + M_S + M_I + M_F + M_O \qquad (2)$$

(3) The Realtionships Between Various Subsystem Masses and Lateral Accelerations

Due to the fact that the relationship between mass and lateral acceleration depends on the level of the technological base, as a result, there is no way to directly give the absolute value relationship between mass and lateral acceleration. Fortunately, when we study optimization problems, it is, in all cases, a study of problems in relative good and bad. It is possible--going through contrast with a basic design--to evaluate the goodness or badness of design plans.

Relationships Between Orbital Power System Masses and Lateral Accelerations:

The magnitudes of lateral accelerations are considered to be in direct proportion to combustion gas flow amounts $(F \sim \dot{m} V_e)$.

Moreover, combustion gas flows are also in direct proportion to the characteristic surface area associated with propulsion combustion chambers or jet tubes $(\dot{m} \sim D^2)$. In conjunction with this, assuming the mass of the engine in itself is in direct proportion to characteristic diameter (Mp ~ D) , as a result, it is possible to set up a form of relationship between lateral accelerations and power system mass as follows

$$M_{P2} = \sqrt{F_2 / F_1} \quad M_{P1} \qquad (3)$$

/7

In the equation, F1 and MP1 are reference engine thrust and mass. Moreover, F2 and MP2 are optimized engine thrust and mass.

Relationships Between Search System Mass and Lateral Accelerations:

If detection signal to noise ratios which are needed for search systems do not change, the closer search range requirements are, the more search system optical apertures can be reduced. On the basis of search range relationship forms as well as the relationships of the five phases associated with the whole process of terminal homing detection (TA), identification (TB), tracking

(TC), correction (TD), as well as limit cycle stability time phases (that is, passive correction phase TE), and, in conjunction with this, assuming search system apertures and masses form a direct proportion, in the end, it is possible to write

$$M_{S2} = \frac{D_2}{D_1} M_{S1} = \frac{R_0 + V_r \sqrt{\frac{2\Delta R M_2}{F_2} + T_E^2}}{R_0 + V_r \sqrt{\frac{2\Delta R M_1}{F_{.1}} + T_E^2}} \cdot M_{S1} \tag{4}$$

In the equation, MS2 and MS3 are, respectively, optimized and reference search system masses. Ro is the range that targets and interceptors fly through in the three phases of search, identification, and tracking. Vr is the relative velocity of the two. ΔR is the medium and terminal homing hand over error which needs correction. M2 and M1 are, respectively, the overall masses of optimized and reference interceptors.

Relationships Between Propellant Masses and Lateral Accelerations:

On the basis of the relationship between propellant consumption amounts and forces produced, consideration is given to active and passive corrections. The relationship between propellant consumption amounts and lateral accelerations is:

$$M_F = \frac{1}{I_S} \left(\sqrt{2\Delta R M F + T_E^2 F^2} - T_E F \right) \tag{5}$$

In the equation, IS is propellant specific impulse.

The Relationship Between Inertial Composite Masses and Correction Ranges ΔR:

The relationship between inertial composite masses and correction ranges ΔR requires considering two types of cases. The first is when permissible values for hand over errors are relatively large. It is possible to opt for the use of gyroscopes with light masses but low precision (for example, making use of optical fiber gyroscopes to replace laser gyroscopes), causing masses to be reduced. The second is when option is made for the use of laser gyroscopes. Due to the fact that light paths and precisions form a direct proportion--it is possible to assume that light paths and dimensions form a direct proportion with mass. As a result,

$$M_I = \begin{cases} M_{I_0} - \Delta M & \Delta R \geqslant \Delta R_C \\ \dfrac{\Delta R_{I_1} M_{I_1}}{\sqrt{\left(\dfrac{\Delta R}{3}\right)^2 - \Delta R_0^2}} & \Delta R < \Delta R_C \end{cases} \tag{6}$$

In the equation, ΔRo is hand over error which is given rise to by other factors besides inertial guidance. ΔM is the reduction in mass which is given rise to by different gyroscopes. ΔRc is hand over error associated with permiting option for the use of low precision instruments.

(4) Constraining Conditions Associated with Lateral Acceleration Options

Upper Limit Constraints on Orbital Control Lateral Accelerations:

Giving consideration to the existence of line of sight angle deviations Δq associated with search system measurements of control loss points, the largest target miss amounts given rise to should be smaller than permissible values. Along with that, giving consideration to the fact that angular constraint velocities produced by continuously initiated maximum thrust Fmax should be smaller than the maximum angular velocity $\dot{q}_{max}$ which measurement systems are capable of measuring, the upper limit constraint expression associated with lateral acceleration is /8

$$F_{max} \leqslant \min\left\{\frac{R_r \cdot \Delta q_{min} K_F \cdot M}{h \cdot \Delta T_{min}}, \frac{Z\dot{q}_{max} \cdot M \cdot R_r}{h}\right\} \tag{7}$$

In the expression, KF is a constant. h is the time interval between two frames. ΔTmin is the minimum pulse time width.

Lower Lateral Acceleration Limit Constraints:

Giving consideration to maximum correction requirements, the lateral acceleration lower limit expression is

$$F_{max} \geqslant \frac{2\Delta R_{max} \cdot M}{T_D^2 + 2T_D \cdot T_E} \tag{8}$$

In the expression, ΔRmax is the maximum deviation which needs correction. TD is the time interval provided in association with lateral accelerations.

(5) Expressions Associated with Interceptor Mass Optimization

Gathering together the expressions described above, interceptor overall mass optimization equation sets are as follows

$$\min\left\{\sqrt{\frac{F}{F_1}}M_{P1}+\frac{R_0+V_r\sqrt{\frac{2\Delta R\cdot M}{F}+T_E^2}}{R_{01}+V_{r1}\sqrt{\frac{2\Delta R_1 M_1}{F_1}+T_E^2}}M_{S_1}\right.$$

$$\left.+\frac{1}{I_S}\left(\sqrt{2\Delta R\cdot M\cdot F+T_E^2F^2}-T_EF\right)+M_I+M_0\right\}\tag{9}$$

$$F\in F_R$$

$$F_R=\left\{\frac{2\Delta R_{\max}M}{T_D^2+2T_DT_E}\leqslant F\leqslant\min\left[\frac{R_r\Delta q_{\min}K_F\cdot M}{h\Delta T_{\min}};\ \frac{2\dot{q}_{\max}MR_r}{h}\right]\right\}$$

$$M_I=\begin{cases}M_{I0}-\Delta M & \Delta R\geqslant\Delta R_C\\ \dfrac{\Delta R_{I1}\quad M_{I1}}{\sqrt{(\Delta R/3)^2-\Delta R_0^2}} & \Delta R<\Delta R_C\end{cases}$$

(6) Interceptor Mass Optimization Solutions

The necessary condition for solving the target function f(X) for minimum values is a first order derivative of zero. The sufficient condition is a second order derivative in the vicinity of x=xo greater than zero. If one assumes that both Ro and Vr are selected as the same value, then, the independent variables associated with f(X) are lateral acceleration F, maximum required correction amount ΔR, and passive correction phase time interval TE. Selecting a first order derivative as zero, one gets the expression below /9

$$\begin{cases}\dfrac{\partial M}{\partial F}=0\\[2mm] \dfrac{M_{P1}}{2\sqrt{F_1F}}+\dfrac{1}{I_S}\dfrac{\Delta RM+T_E^2F}{\sqrt{2\Delta RMF+T_E^2F^2}}=\dfrac{V_rM_{S1}\Delta RM}{AF\sqrt{2\Delta RMF+T_E^2F^2}}+\dfrac{T_E}{I_S}\\[2mm] A=R_{01}+V_{r1}\sqrt{\dfrac{2\Delta RM_1}{F_1}+T_{E1}^2}\end{cases}\tag{10}$$

$$\begin{cases}\dfrac{\partial M}{\partial T_E}=0\\[2mm] \dfrac{RT_E}{I_S\sqrt{2\Delta RMF+T_E^2F^2}}+\dfrac{V_rM_{S1}T_E}{A\sqrt{2\Delta RMF+T_E^2F^2}}=\dfrac{1}{I_S}\end{cases}\tag{11}$$

$$\begin{cases} \frac{\partial M}{\partial R} = 0 \\ \frac{M \cdot F}{I_S\sqrt{2\Delta RMF + T_E^2 F^2}} + \frac{V_r M_{S1} \cdot M}{A\sqrt{2\Delta RMF + T_E^2 F^2}} = \frac{\Delta R_{I1} M_{I1}}{9} \frac{\Delta R}{\left(\frac{\Delta R^2}{9} - \Delta R_0^2\right)^{\frac{3}{2}}} \end{cases} \quad (12)$$

IV. ORBITAL CONTROL LATERAL ACCELERATION OPTIMIZATION EXAMPLE

1. Prerequisite Conditions Associated with Orbital Control Lateral Acceleration Optimization Example

Due to the fact that the optimization of equation (9) requires refering to a certain datum to be carried out, as a result, option is made for the use of a number of interceptor parameters associated with the U.S. SDI project to act as references. Typical parameters associated with reference interceptors are assumed to be as follows.

(1)	Overall interceptor mass	50kg
(2)	Orbital control lateral acceleration	500N
(3)	Control initiation range	150km
(4)	Detection range	250km
(5)	Relative velocity	9km/s
(6)	Correction Distance	1.5km

Opting for the use of the parameters described above and equations (10-12), it is possible to solve for optimization results as follows.

(1) Orbital control lateral acceleration 1500-2500N
(2) Mass Possible to reduce 15-20% of variable mass
(3) Control initiation range 70-80km

2. Result Analysis

Assuming that space interceptors opt for the use of 4g lateral overloads to carry out corrections--as compared to 1g in the original design--the advantages are as follows.

(1) If the total correction energy is maintained invariable or slightly relaxed, the total interceptor mass can be maintained invariable or slightly reduced.

(2) Control initiation range associated with corrections is reduced to half the original design.

(3) There is a requirement with respect to search system sensitivities to drop one fold. Development difficulty and expenses go down an order of magnitude.

(4) There is a large scale drop with regard to inertial guidance system measurement precision, even to the point of reaching an order of magnitude. /10

(5) Due to opting for the use of terminal prediction strength

switch guidance, there are no special requirements with respect to orbital control engine pulse width or precision.

From the influences above, it is possible to see that, under conditions where overall performance is maintained invariable--option being made for the use of large lateral acceleration corrections--it is possible to lower degrees of subsystem difficulty to a great extent.

V. CONCLUSIONS

As far as designing terminal homing systems for a complicated space flight vehicle is concerned, good overall design concepts are unusually important. They are capable of relatively easily resolving subsystem problems which are difficult to solve, making for a rational distribution of responsibilities with regard to development difficulties, effectively lowering the development difficulties associated with various subsystems, and also causing even greater rationality in systems as a whole as well as even easier realization, thus increasing development efficiency.

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